Économie publique/Public economics

28-29 | 2012/1-2
Varia

Curative Activities of Township Hospitals in Weifang Prefecture, China: An Analysis of Environmental and Supply-side Determinants

Aurore Pélissier, Martine Audibert, Jacky Mathonnat, Xiaoxian Huan et Anning Ma

OpenEdition Journals

Édition électronique
URL : http://journals.openedition.org/economiepublique/8828
ISSN : 1778-7440

Éditeur
IDEP - Institut d'économie publique

Édition imprimée
Date de publication : 25 novembre 2012
Pagination : 71-94
ISSN : 1373-8496

Référence électronique
Aurore Pélissier, Martine Audibert, Jacky Mathonnat, Xiaoxian Huan et Anning Ma, « Curative Activities of Township Hospitals in Weifang Prefecture, China: An Analysis of Environmental and Supply-side Determinants », *Économie publique/Public economics* [En ligne], 28-29 | 2012/1-2, mis en ligne le 20 décembre 2012, consulté le 30 avril 2019. URL : http://journals.openedition.org/economiepublique/8828

public economics

économiepublique

Revue de **l'Institut d'Économie Publique**

Deux numéros par an

nº 28-29 – 2012/1-2

idep

Curative Activities of Township Hospitals in Weifang Prefecture, China: An Analysis of Environmental and Supply-side Determinants

Aurore Pélissier, Martine Audibert, Jacky Mathonnat, Xiaoxian Huang *

Anning Ma **

Summary

Township hospitals are an important link in the Chinese rural healthcare system, but their use has declined since the 1980s in the wake of successive waves of socio-economic reform. Based on longitudinal data covering 9 years (2000-2008) and 24 township hospitals randomly selected from Weifang prefecture (Shandong province, China), this article analyses the environmental and supply-side determinants of the volume of curative activity at township hospitals, as measured by number of outpatient visits and number of discharged inpatients. Hausman-Taylor and Fixed-Effect Vector Decomposition estimators are used in order to handle time-invariant variables. Cross-comparison of the results of the two estimations highlighted similar outcomes. The study finds that the New Rural Cooperative Medical Scheme phased in from 2003 has helped increase the activity of township hospitals, but that there are still financial barriers preventing access to expensive medical services. The analyses also underline also that the system of referrals

*. Cerdi-IESSP-CNRS.

**. Vice-President of Weifang Medical University.

Correspondance : Cerdi, Institut d'Économie de la Santé et de Santé Publique, 65 boulevard F. Mitterrand, 63000 Clermont-Ferrand ; pelissier.aurore@gmail.com (corresponding author) ; martine.audibert@udamail.fr ; jacky.mathonnat@udamail.fr ; huang.xiaoxian@gmail.com. Anning Ma was Director of Weifang Health Bureau during the period of the study.

between health facilities levels should be tightened up, and that township hospitals, which are visibly over-sized, needs to re-scaled to fit environmental factors.

Résumé

Les hôpitaux municipaux, qui sont un maillon essentiel du système de santé rural Chinois, ont été affectés par les réformes économiques successives depuis les années 1980 et ont ainsi vu leur fréquentation s'affaiblir. À partir d'observations longitudinales sur neuf années (2000-2008) et 24 hôpitaux municipaux sélectionnés de façon aléatoire dans la préfecture de Weifang (Province du Shandong, Chine), cet article analyse les facteurs d'environnement et d'offre qui influencent le volume des activités curatives des hôpitaux municipaux, mesuré par le volume de consultations externes et d'hospitalisations. Afin d'estimer l'effet de variables invariantes dans le temps, deux estimateurs sont utilisés : Hausman-Taylor et Fixed-Effect Vector Decomposition. Les résultats des estimations des deux estimateurs sont similaires. Ils montrent que le système d'assurance mutualiste graduellement introduit à partir de 2003 influence positivement l'activité des hôpitaux municipaux, même s'il subsiste des barrières financières à l'accès aux soins de santé coûteux. L'analyse souligne aussi que les liens de référencement entre les différents niveaux de structures de santé devraient être renforcés et que la taille des hôpitaux municipaux, qui semble surestimée, doit être adaptée en fonction des facteurs environnementaux.

Keywords: China, Healthcare Services, Health Insurance, Hausman-Taylor, Fixed-effect Vector Decomposition.

Mots-clés : Chine, services de santé, assurance maladie, Hausman-Taylor, vecteur de décomposition des effets fixes.

J.E.L. : G22, I1, I38, O12

1. Introduction

Healthcare in rural areas of China is delivered through a three-tier system, running from lower-tier village health stations (VHSs) up to township hospitals (THs) and then upper-tier county hospitals. This pyramidal hierarchy allowed effective cooperation between health facilities. The lower-level health facilities deliver basic medical services and are also responsible for patient referrals to upper-level health facilities. The medical services offered increase in complexity with each higher tier of health facilities, and upper-tier levels offer technical support to lower-tier levels.

THs play a pivotal functional role in the Chinese rural healthcare system. They act as the link connecting VHSs to county hospitals. They supervise the quality of services delivered at VHSs, and offer technical backup where needed. They are also designed to play a "gate keeper" role, filtering patients-in-need up to upper-level hospitals (county, provincial or central-level hospitals). THs have four missions: offering curative treatment for non-highly-severe diseases (medical consultations and basic in-patient care), ensuring the diffusion of preventive services, training health workers at VHSs, and administrative management of VHS workers. Curative and preventive activities are delivered via two distinct departments, each of which has their own medical staff. THs are therefore the main provider of primary healthcare in rural areas (Hillier and Shen, 1996). However, in the wake of economic transition since the 1980s, the efficiency of the health system, and particularly THs, has declined considerably (Liu *et al.*, 1996).

The functioning of the rural healthcare system was seriously dented by deep-seated change in the social fabric caused by the economic transition process, which is one of the main reasons for the failure of THs (Hsiao, 1995; Eggleston *et al.*, 2008) [1]. The budget decentralization process (1979) led to a decrease in public spending. As government subsidies were primary source of funding for THs, this change left many of them struggling financially. Faced with a shortage of public financing and the hospitals management reform introduced in 1983, health facilities – and particularly THs – were incited to make up the budget deficit by increasing business income (Hillier and Shen, 1996; Liu *et al.*, 1996). These trends forced THs to look for other sources of income to cover their costs. Moreover, the rule governing how subsidies were allocated was not clearly defined and not linked to the performance of the health facilities. The knock-on effect, visible from the 1990s on, was a string of dysfunctions, including a drastic hike in healthcare prices, an increase in average length of stay, overuse of expensive technologies, over

1. For more details on the history of the healthcare system in China, see: Hsiao (1984, 1995), Hillier and Shen (1996), Liu *et al.* (1996), Liu *et al.* (2003a), World Bank (1997), Eggleston *et al.* (2008), Yip and Hsiao (2008), Wagstaff *et al.* (2009b).

prescription of drugs, and overall decline in productivity and efficiency (Hillier and Shen, 1996; Liu *et al.*, 2003b, Audibert, Dukhan and Mathonnat, 2009). The supply of expensive curative activities increased to the detriment of basic, preventive and curative care (Hsiao, 1995; World Bank, 1997). In addition, the medical services delivered by THs partly overlapped those delivered at county hospitals or VHSs. Market competition pushed many THs into further financial hardship, ultimately sparking a decline in healthcare quality and efficiency (Hsiao, 1995), and the process continues today. On the patient-consumer side, the implementation of the household production responsibility system in rural areas (1981) caused the collapse of agricultural cooperatives, subsequently taking with it the Cooperative Medical Scheme (CMS) (Hsiao, 1984). At the beginning of the 1990s, less than 10% of the rural population had medical insurance coverage, whereas in 1975, coverage was virtually universal. The collapse of the CMS dismantledthe medical referral system. Patients went directly to county or upper-level hospitals for services with better quality (Liu et *al.*, 1996; World Bank, 1997). This trend was strengthened by the increase in rural income (Liu *et al.*, 1996) and the worsening quality of health services at TH level.

Organizational reforms undertaken by the government were set up, including measures to reinforce the delivery of basic medical healthcare services at primary level (i.e. VHSs and THs). At the same time as strengthening the supply-side, the government introduced the 2003 New Rural Cooperative Medical Scheme (NRCMS), a community-based health insurance scheme for the rural population, in order to support the demand-side. Administered at county level, the NRCMS is a voluntary-based household scheme financed by local and central government subsidies and household premiums. The objectives were to reduce the financial burden caused by the cost of health services and to provide the rural population with more affordable healthcare (Wagstaff *et al.*, 2009b). These measures are expected to improve TH activity.

In order to bring gain a sharper picture of the potential effect of this policy, it appeared essential to pinpoint the factors that explain activity levels at THs. This paper analyzes the environmental and supply-side determinants of TH-offered curative activities. As health policy is mainly driven by local governments, and given the significant differences in socioeconomics conditions between provinces in China (Feng and Song, 2009), this empirical study is conceived as a case study focusing on a sample of THs [2] in Weifang prefecture (Shandong province).

Looking at the international literature, the paper brings two main original features: (i) it is “supply-side”-focused, whereas most of the literature is “demand-side”-oriented; (ii) we use a new approach that is still only emerging in the

2. The sample represents 14% of the total number of THs of Weifang prefecture.

literature, i.e. the FEVD technique, as explained below. We cross-compare the results of the classical Hausman-Taylor approach and the FEVD estimator, and show that both methods lead to similar conclusions.

The remainder of the paper is organized as follows. Section 2 presents the data and the sample characteristics. The methodology is examined in Section 3. This is followed by a presentation of the empirical results (Section 4), before concluding with a summary of the main findings and their implications for policy (Section 5).

2. Data

The data are taken from a survey led on a sample of 24 randomly-selected THs in Weifang prefecture over a 9-year period (2000-2008). The survey was conducted in collaboration with Auvergne University Center for Studies and Research on International Development (CERDI), the Weifang Health Bureau, and the Medical University of Weifang. Data were collected from the Weifang Health Bureau database and from the registers of the THs, and were verified and completed with interviews. The dataset includes characteristics of the county and township administrative divisions and the THs, and data on the TH-led medical activities, financing, staff and equipment.

Located in Shandong province, Weifang is a prefecture-level city ("*dijí shi*") which has under its jurisdiction 12 counties ("*xian*"). The 24 THs of the sample, representing 14% of all the THs run by Weifang prefecture, belong to six counties and are situated in 24 rural townships ("*zhen*").

Table 1 presents descriptive statistics on the environmental characteristics of the THs. Over the study period, the THs operated in a changing environment. Population density increased by 6% but the population remained mainly rural. Average rural net income per capita (constant prices) was 3,338 Yuan in 2000 and rose to 5,557 Yuan in 2008, i.e. a 66% increase over the period. NRCMS coverage increased between 2003 and 2008 to reach about 97.51% of the population of the townships. The NRCMS scheme was phased in progressively from 2003 and covered all townships by 2006. Number of VHSs also increased, from an average 25 VHSs per township in 2000 to 37 in 2008. This grassroots-level reinforcement of the rural health structure could add pressure to the competition between VHSs and THs. Nevertheless, the number of VHSs per 10,000 households – a ratio reflecting physical accessibility to VHSs – remained fairly stable over the period. The distance separating the THs from the county hospital is between 10 and 50 kilometers, with an average of 25 kilometers. The good quality of roads in Weifang prefecture (information gained from our interviews) reduces the physical constraint

Table 1 : *Environmental characteristics of township hospitals*

Mean of:	**2000–2008**	2000	2003	2006	2008	**2000–2008 (%)**
Number of households per square kilometer	**129**	125	127	129	133	**6.40**
Share of rural (%)	**92.79**	94.46	93.56	91.86	92.57	**–2.00**
Rural net income per capita (Yuan)	**4,259**	3,338	3,751	4,938	5,557	**66.48**
Village health stations	**31**	25	30	32	37	**47.06**
Village health stations per 10,000 households	**24**	24	25	25	21	**–14.29**
Distance to county hospital (km)	**24.85**	24.85	24.85	24.85	24.85	**0.00**
NRCMS coverage (%)	**44.2**	0	17.08	93.5	97.51	**–**

Source : Authors' database.
Note: Monetary terms are in Yuan and are expressed in 2000 constant prices, based on the Shandong province price index.

Table 2 : *Human and physical resources of township hospitals (TH)*

Mean of:	2000-2008			All THs			
	All THs	Central THs	General THs	2000	2003	2006	2008
Curative-care medical staff	45	70	31	39	43	45	60
Beds	39	49	32	33	34	37	59
Equipment: X-ray	1.35	1.65	1.16	1.21	1.21	1.33	1.75
Echograph	1.55	1.91	1.33	1.29	1.33	1.63	2.17
Electrocardiogram	2.05	2.64	1.69	1.71	1.71	2.04	3.17

Source : Author's database.

of gaining access to the county hospital or upper-tier health facilities, and thus contributes to higher competition between THs and county hospitals.

Based on our dataset (Table 2), the size of the THs is relatively small, counting an average 39 beds and 45 curative-care medical staff over the period. THs are administratively classified as either central or general depending on size of the hospital, with central THs being larger than general THs. The dataset consists of 9 central THs and 15 general THs. General THs count on average 32 beds and 31 staff over the period, whereas central THs register 49 beds and 70 employees. Furthermore, central THs are better equipped than general ones. Overall, the size of THs, as measured by the human and physical resources available, increased over the period.

THs offer two kinds of curative healthcare services: *medical consultations*, measured by volume of outpatient visits, and *inpatient care* measured by volume of inpatients discharged. Table 3 summarizes the average activity of THs. TH activity consists mainly of medical consultations, which account for at least 95% of the volume of curative healthcare services delivered over the period. The pattern is similar when central and general THs are observed separately, although central THs average a higher volume of curative activities than general THs, particularly

Table 3 : *Trends in the average volume of curative activities at township hospitals*

	All THs		Central THs		General THs	
Mean of:	Outpatients	Inpatients	Outpatients	Inpatients	Outpatients	Inpatients
2000	26135	921	38413	1120	18768	801
2001	27187	997	42372	1156	18077	902
2002	25554	899	40358	1230	16671	702
2003	25350	864	40703	1263	16138	624
2004	26561	955	40600	1308	18137	744
2005	26641	1082	39248	1481	19076	842
2006	29269	1476	41509	1991	21926	1 167
2007	38643	1863	49084	2255	32878	1 628
2008	48245	2184	65540	2633	37867	1 915
2000-2008 (%)	845	137	71	135	102	139

Source : Authors' database.

Table 4 : *Performances of township hospitals*

	2000-2008			All THs			
Mean of:	All THs	Central THs	General THs	2000	2003	2006	2008
Outpatients per curative staff per day	3.13	2.75	3.35	2.84	2.62	3.02	4.94
Inpatients per curative staff per month	4.05	2.93	4.71	3.38	2.89	5.16	5.56
Bed occupancy rate (%)	46.78	55.78	41.37	44.12	37.69	54.77	61.47

Source : Authors' database.

in terms of number of outpatients treated (almost twice as many outpatient visits). In contrast, the *increase* in the volume of curative activities is higher at general THs than central THs, especially when considering volume of medical consultations. Overall, after remaining fairly stable over the period 2000-2005, volume of outpatient visits and volume of inpatients discharged increased from 2006, which marks the year when extension of NRCMS coverage reached all townships.

TH performances are rather weak, as shown by the productivity of curative medical staff and bed occupancy rates. The productivity of the curative medical staff is low over the period, averaging just 3 outpatients per curative health worker per day and 4 discharged patients per month, with staff at general THs outperforming central THs. Bed occupancy rate reaches just 47% on average, with central THs outperforming general THs over the period. To conclude, productivity and the bed occupancy rate declined until 2003 (the year of the introduction of the NRCMS), and then increased.

3. Methodology

This study deals with estimating the determinants of volume of TH curative activities, namely medical consultations and inpatient care, in two separate regressions.

3.1. Framework

Medical care utilization is a function of both individual and environmental factors, as explained in Andersen and Newman (2005). Much of the literature concentrates on the individual determinants of the healthcare utilization. From household surveys, studies try to capture individual motivations, in relation to individual capabilities, pre-disposing factors and health needs, in the decision to seek healthcare. Here, we focus on a different perspective. Using data at hospital level, this paper considers the supply side, and thus takes a complementary view to analyze factors influencing TH activity. The utilization of healthcare services hinges on two major components: the resources of the health facilities and the organization structuring access to and delivery of healthcare. Health facilities are decisional units, with their own characteristics and their own incentives for attracting patients. In addition, their behavior and the volume of curative activities they deliver are influenced by environmental factors and by healthcare system organization.

Based on the literature and on the specificity of the Chinese/Weifang context, we focused our investigations on two categories of determinants that could affect the curative activity of THs: the environmental factors tied to the characteristics of the townships where THs are located, and the characteristics of the THs, which are linked to their resources. Furthermore, as curative and non-curative (mainly preventive) activities share different production processes, non-curative activity was introduced into the analysis as it may compete with curative activity.

3.1.1. Environmental factors

Environmental factors are set at township level. Three categories of factors are considered [3].

The density of the township population (*density*), measured as the number of households per square kilometer, reflects the potential demand for curative activities.

3. Some of them can be viewed as “enabling characteristics of the community” in which the townships are located, and which “can affect the use of services” (Andersen and Newman, 2005)

Financial barriers can constrain the utilization of the curative medical services offered by the TH. Rural net income per capita [4] (taken in logarithm, as Ln(rural net inc. p.c)) in the township represents the township's economic development level and gives an indication of patients' capacity to pay. Numerous empirical studies on China have shown that out-of-pocket payment plays a big part in medical expenditures (World Bank, 1997; Wagstaff *et al.*, 2009b), and access to healthcare services is directly dependent on the individual's capacity to pay (Wagstaff *et al.*, 2009b). Therefore, we assume that volume of demand is influenced by level of income per capita, as shown in the literature. The distribution of revenue within the township could also be an important factor in the demand for medical services (Audibert *et al.*, 2002), but this information is not available in our dataset. Health insurance is an important factor to be considered. As insurance is designed to increase the insured's capacity to pay, it is expected to increase the demand for medical services (for China, see Henderson *et al.*, 1998; Dong *et al.*, 1999; Hu *et al.*, 1999; Liu *et al.*, 2002). Three variables are used to capture different dimensions of the insurance system: i) a dummy variable, *participation,* that takes the value '1' if the township in which the TH is located is covered by the NRCMS, and '0' otherwise; ii) percentage of the population covered by the NRCMS (*NRCMS coverage*), which captures the insurance coverage rate in the township; iii) the reimbursement rates for outpatient or inpatient care at TH level (*reimbursement rate*), which measures the depth of insurance protection, with the benefits package being the same across townships. Each variable is introduced into three different models due to the high correlation between them.

The availability of alternative health facilities, at both village and county level, can also affect the volume of medical activities at THs. First, like THs, VHSs deliver primary health care and can also refer patients up to TH level, and so their availability may have either a complementarity effect or a substitute effect for TH activities. Secondly, THs deliver inpatient care, which is equally available at county hospital level. Some studies highlight competition between THs and the county hospitals, as some patients elect to go directly to the county hospital and bypass THs due to their reputation for providing relatively low-quality healthcare (World Bank, 1997). Two variables are used in order to capture these effects: number of households per VHS available in the township (*# HH per VHS*), and distance between the TH and the county hospital (*distance to CH*), based on the rational that a large distance may prompt users to choose the nearest health facility.

Other variables reflecting the environmental characteristics of THs are not taken into account. The percentage of rural population is not included as there is little disparity across townships, where the vast majority of the population

4. All monetary terms are in Yuan normalized to 2000 constant prices, given the Shandong province price index.

is rural. Concerning the characteristics reflecting health status in the township, any information available at this level is of low quality and, according to the Chinese authorities we liaised with, the sanitary and health profile within Weifang prefecture is not significantly heterogeneous.

3.1.2. Characteristics of the township hospitals

The characteristics of THs can be divided into three sets of variables: type of the TH, physical characteristics, and financial characteristics reflecting the resources dedicated to health services delivery.

As stated earlier, THs are classed as either central or general. The dummy variable *hospital level* takes the value ‘1’ if the TH is central and ‘0’ otherwise (i.e. general).

The physical characteristics measured are number of curative health staff (*curative staff*) and number of operational beds (*# of beds*), which are features designed to capture the hospital’s capacity to respond to demand for healthcare and supposed to exert an attractiveness effect. Due to their high cross-correlation, these two indicators cannot be added to the model at the same time. Thus, following discussions with our Chinese experts, we decided to include the first indicator in the estimations on number of outpatient visits and the second one into the estimations on volume of inpatients [5].

THs have financial constraints to contend with. We suppose that more restrictive financial constraints will spur the medical activities of THs. Two variables are considered: the subsidies received by the THs (*subsidies*) and the budget balance. Government subsidies are vital resource in helping the hospital tackle the issue of their budget deficit. Subsidies are paid at the beginning of the year, but the amount allocated is impossible to predict as it results from negotiations between the government and local hospitals. This financial source depends more on the interpersonal relationship (“*guan xi*”) between government officials and the hospital administrators than on the hospital’s actual results, cost-efficiency performance, or activities. This makes it doubly interesting to assess the effect of subsidies on TH activities. We preferred to use the total subsidies received in the current year rather those received in the previous year, as the amount of subsidies changes considerably from year to year and is the result of in-year discussions with the Health Bureau. It is therefore reasonable to consider that TH staff base their current activity less on past subsidies than on their ability to obtain greater subsidies for the current year.

5. In Section 2, we stressed that the size of the TH is linked to its type, central or general. Such a relationship can create a correlation coefficient bias. In order to control for this, we verify that coefficients of variables are stable when one of these two variables is removed.

Contrary to the general belief that health facilities need to insure the sustainability of their establishments and avoid deficit, the majority of THs in our sample are indeed in "business" deficit (only 3 THs registered a positive balance in one year and 1 TH in two different years). Although this deficit is reduced to some extent by government subsidies, there is still a large gap between resources and expenditures in many THs that then has to be financed *ex post.* Based on discussions with Chinese experts, the financial stress involved does not appear unbearably tough, and THs have no commitment to ensure a no-negative budget balance. Consequently, this variable is not included in the analysis, as in concrete terms, TH managements are relatively untroubled by their financial situation, as they operate under what could best be described as "soft budget constraints".

3.1.3. Non-curative activities

In the 1990s, financial imperatives prompted THs to privilege curative care to the detriment of preventive care (World Bank, 1997). However, the provision of preventive healthcare is an integral functional component of THs. The substitutability of curative and preventive services from a "supply-side perspective" is not an acutely relevant issue, because THs normally dispose of staff dedicated specifically to preventive care activities. Here, we expect to see a relative complementarity between the two kinds of services, since by offering preventive care, the hospital can identify those patients that need curative care, as well as build up its reputation by "attracting" patients to its curative care (and *vice versa*). In the empirical literature, the link between preventive and inpatient activities is often studied over time, with authors testing whether the use of preventive activities in an initial period has an influence on the use of inpatient services later (Chen *et al.*, 2007; Tian *et al.*, 2010). To measure preventive activities, we use the actual number of vaccinations carried out by the TH per preventive health worker (*vaccination per preventive staff*) as a rough proxy variable.

3.2. Choice of Econometric Model

3.2.1. Panel data analysis of unobservable heterogeneity

Fisher statistics (Table 5) show the existence of individual-specific effects. We use the panel data approach rather than the data pooling method in order to take into account the presence of unobservable heterogeneity. The choice has to be made between the fixed or random effects, and centres on the way in which unobservable heterogeneity will be treated in the estimations. The first approach deals with unobservable heterogeneity by including a dummy variable for each individual (cross-sectional units), whereas the second approach captures individual

Table 5 : *Tests of the model*

	Outpatient visits	Inpatients care
Presence of individual effects		
Fisher statistic	0.000	0.000
Fixed-effect versus *random-effect*		
Hausman test, regression-based (Wooldridge, 2002)	0.0384	0.0026
Mundlak approach, regression-based (1978)	0.0450	0.0002

Source : Authors' calculation using STATA.
Note: the probability of the test is given. Tests are performed on the basic model; that is to say, with the participation dummy as indicator for the NRCMS. For the two others specifications (NRCMS coverage and reimbursement rates as indicator for insurance) conclusions are similar. Standard errors are corrected for heteroskedasticity and clustered at township level.

heterogeneity in the error term [6]. Each method has its pros and cons. The fixed-effect model offers consistent estimators but does not make it possible to estimate time-invariant variables since it is based on the within operator (it subtracts from the variables their mean over time, with the result that time-invariant variables have a mean equal to their value and the within estimator leads to a null value of the within transformation of these variables). The random-effect model increases the efficiency of the estimations but imposes a strong assumption that individual effects are not correlated with explanatory variables and are distributed independently of the regressors.

In order to discriminate between these two approaches, a Hausman test has to be run. Two robust [7] Hausman tests are conducted: the test proposed by Hausman (1978) [8] and the test proposed by Mundlak (1978) [9]. Under the null hypothesis of the Hausman test, the estimators from the random-effect model are not systematically different from those from the fixed effect. If the null hypothesis cannot be rejected (probability higher than 10%), we consider the estimators from the random-effect model to be consistent. Otherwise, if the null hypothesis is rejected (probability lower than 10%), only the fixed-effect model is consistent and unbiased. Both tests led to the conclusion that the null hypothesis was rejected for our estimations (Table 5). The Mundlak test (1978) – also see Wooldridge (2002) – gives the same probability, confirming that the fixed-effect model was the more appropriate choice for this study (Table 5).

6. See Wooldridge (2002) and Baltagi (2005).
7. Tests are performed with standard errors corrected for heteroskedasticity and clustered at township level.
8. The statistic is computed with a Wald test on a regression-based estimation (Wooldridge, 2002).
9. Mundlak tests (1978) offer an alternative form of the null correlation hypothesis (Wooldridge, 2002).

3.2.2. Dealing with time-invariant variables

The Hausman test ultimately rejects the random-effect model and concludes that the fixed-effect model is better suited to analyzing the determinants of TH-led curative activities. However, working with this kind of estimator makes it impossible to estimate time-invariant variables. We therefore combine two approaches, derived from the basic fixed-effect model, to estimate both time-varying and time-invariant covariates. The first is the Hausman-Taylor (1981) estimator, and the second is a three-stage approach developed by Plumper and Troeger (2007) dubbed "Fixed-Effect Vector Decomposition".

The Hausman-Taylor estimator is an approach that employs instrumental variables. It combines both the random-effect and fixed-effect models. As explained earlier, the random-effect model can estimate time-invariant variables but imposes a null correlation between the specific effects and the covariates. Hausman-Taylor deals with this restrictive assumption by allowing some variables considered as endogenous, i.e. correlated with individual effects. The variance matrix of the composite errors keeps the random structure, but the variables suspected to be correlated with the individual effects are instrumented by their within transformation (Wooldrige, 2002). According to Hausman-Taylor (1981), four types of variables need to be defined: X1, X2, Z1 and Z2. Variables labeled X refer to the time-varying variables, while variables labeled Z are the time-invariant variables. They are tagged 1 when they can be considered exogenous and 2 when they are endogenous (endogeneity comes from potential correlation with individual fixed effects). How are our endogenous and exogenous variables defined? The Hausman-Taylor estimator should produce estimations close to the fixed-effect estimator for time-varying variables. Thus, a Hausman test run between the fixed-effect model and the Hausman-Taylor model emerges the best specification.

Fixed-effect vector decomposition (FEVD) allows us to estimate time-invariant (or rarely-changing) variables [10] with a fixed-effect model. The process follows a three-stage procedure [11]. First, the basic fixed-effect model is run. The "estimated unit fixed-effects" are retained. Second, these "estimated unit fixed-effects" are regressed on the time-invariant variables. The purpose is to separate the unit fixed-effect into two parts: an part that is explained (by the time-invariant variables), and an unexplained part, which is simply the residual of the second-stage regression. Third, the basic model from stage 1 is re-estimated with the pooled OLS, but with an added covariate: the residual from stage 2. According to Monte-Carlo experiments, "the FEVD performs better than the Hausman-Taylor model, pooled

10. A variable is defined as "rarely changing" when the ratio of the between variance to the within variance of the variable is at least 2.8 (Plumper and Troeger, 2007).

11. See Plumper and Troeger (2007) for a more in-depth look at the methodology.

ordinary least square, and the random-effect model" (Plumper and Troeger, 2007).

3.2.3. The econometric model

Let Y_{it} be the number of outpatient visits or the volume of inpatients discharged, and let X_{it} simultaneously contain: constant, explanatory variables varying across time and between cross-sections, time-invariant variables, and residuals of the outpatient regressions in the inpatient estimations [12]. The general model estimated is:

$$\ln Y_{it} = X_{it}\beta + \lambda_t + v_{it} \tag{1}$$

Year dummies (λ_t) are introduced in order to control for common shocks affecting all THs at the same time [13]. For continuous explanatory variables, the coefficient is interpreted as follows: when X increases per one unit, Y varies per (β*100)% (except for the in-logarithm variable, coefficients directly give the elasticity value). For dummied explanatory variables, elasticity is calculated by the following formula: $[e^{(\beta)} - 1] * 100$.

There are two provisos regarding the specification of the Hausman-Taylor and FEVD regressions. With the Hausman-Taylor estimator, 5 time-varying variables are considered endogenous (X2): density, curative health staff or number of operational beds, total subsidies, and number of vaccinations per preventive staff. With the FEVD estimator, two kinds of variables need to be defined: time-invariant variables and rarely time-invariant variables. The first type encompasses the distance and the hospital level variables. No variables are considered as rarely time-invariant.

4. Results

Results are presented in Table 6 for volume of outpatient visits and Table 7 for volume of inpatient care. For each curative activity, The tables list the results of the Hausman-Taylor and FEVD methods for each curative activity [14]. For each

---

12. The volume of inpatients can be partly determined from the volume of outpatient visits, but the determinants are supposed to be the same for both activities. Attempting to include number of outpatient visits into the inpatient estimation leads to endogeneity issues. So, in order to take into account both problems, residuals from the outpatient regressions are included in the estimations of the determinants of number of inpatients (in line with the instrumental variables approach).
13. The Fisher statistic shows that year dummies are jointly significant, at P=0.0289 and P=0.0049for outpatient and inpatient specifications, respectively.
14. The results of estimations with the fixed-effect estimator are available upon request. Coefficients obtained on the time-variant variables with the fixed-effect estimator are not statistically different from those obtained with Hausman-Taylor and FEVD estimations.

method, the table presents three specifications on the insurance indicator used in the estimation: i) column 1 shows the specification with the participation dummy, ii) column 2 with the NRCMS coverage rate in the township and, iii) column 3 with reimbursement rate as insurance measure.

Despite the potential appeal of the FEVD estimator, the literature remains relatively skeptical over the method's estimation strategy and the calculation of the variance-covariance matrix (Greene, 2011). Hausman-Taylor is more consensual, despite a lack of objective criteria to specifyeach type of variable. There are proponent and opponents of both methods. *Our results show that Hausman-Taylor and FEVD estimations give similar results for both kinds of activities*, sharing the same significant variables and the same sign of the coefficient of significant explanatory variables. Moreover, the coefficients under Hausman-Taylor were very close to coefficient under FEVD specifications.

4.1. Environmental Factors

Density. We expected the increase in density to reflect an increase in potential volume of demand for healthcare services at THs (Tables 6 and 7). However, the results indicate that population density negatively influences both volume of medical consultations and volume of inpatient care at TH level. Zhang *et al.* (2011) also highlighted this negative link between population density and outpatient visits at VHSs in China. Crowded townships are better serviced with alternative healthcare facilities (VHSs)[15] that are able to deliver some of the same medical services as those proposed by THs while being closer to urban areas also offering substitute health facilities. Moreover, we found evidence that THs are oversized in high-density townships. These insights point to the importance of adequately mapping healthcare facilities to properly size and scale township hospitals to fit the TH's host environment. Coverage plan and size of healthcare facilities are often based on population-centric criteria. Furthermore, this result is also underlined by the significance of the coefficient on the VHS density variable. When the density of VHSs decreases, the volume of TH-led medical activities increases. Results show that an increase of 100 households per VHS leads to a 9% increase in number of TH outpatients (Table 6) and a 7% increase in number of discharged inpatients (Table 7). Two explanations can be put forward. The first stems from the referral mechanism. As the population served by VHSs increases, the number of cases referred from VHSs to THs will also increase. Second, any increase in number of households per VHS will make access to the VHS care more difficult, as the waiting list is liable to rise. THs will consequently enjoy an increase in medical activities

15. The coefficient of correlation between the number of households in the township and the number of village health stations in the township equals 0.6403.

as demand for medical consultations switches from VHSs over to THs. It would have been useful from a policy perspective to pinpoint the kind of diseases that follow this pattern, but data was unavailable.

Distance to the county hospital. This factor carries next to no importance (Tables 6 and 7). THs located far from county hospitals are not in a better position than THs located close by. Interviews with Chinese partners confirmed that geographical barriers on access to county hospital are weak as the quality of the road network is good, and descriptive statistics show that county hospitals tend to be close to townships anyway (see section 2). However, the non-significance of the coefficient does not mean there is no competition effect between THs and county hospitals, but just that distance is not an influential factor in the decision to consult at a TH or a county hospital. The quality of care delivered at both levels is almost certainly a discriminating factor in this choice, but cannot be tested given the available data.

Role of insurance. The curative activity is covered under the NRCMS scheme (Tables 6 and 7). Whatever the insurance indicator considered, insurance plays a positive role on volume of outpatients and on volume of discharged inpatients. When the NRCMS is available in the township, outpatient volume at TH facilities improves by 16% (Table 6, Column 1) and volume of discharged inpatients increases by 57% (Table 7, Column 1). Along the same lines, coverage rate and reimbursement rate both have positive effects, although elasticity is <1. When insurance coverage rate increased by 10 percentage points, medical consultations at THs increased by 2% (Table 6, Column 2), and when reimbursement rate increased by 10 percentage points, medical consultations at THs increased 9% (Table 6, Column 3). Volume of inpatient care followed the same pattern, increasing by 6% and 9% when coverage rate and reimbursement rate increased 10 percentage points, respectively (Table 7, Columns 2 and 3). The NRCMS effect is higher for inpatient care than for medical consultations. This effect is unsurprising, as the NRCMS is "hospitalization-oriented" (Dong, 2009).

The NRCMS has a greater positive effect on volume of outpatients in poor areas [16] than non-poor areas (Table 6, column 4). In contrast, the NRCMS effect on volume of inpatient care delivered is not significantly different between poor and non-poor areas (Table 7, column 4).

Income per capita. Township development level has a heterogeneous effect on curative services delivery. Township development level has no effect on volume of outpatient visits at THs (Table 6). The swift, mass extension of the NRCMS scheme across all townships can explain this result, as the insurance coverage offered lowers the financial barriers to access to basic primary healthcare services at TH

16. Poor is calculated from the rural net income per capita of the township. A township is considered as poor when it belongs to the quintile 1 (townships belonging to the 20% of the poorest townships).

level for the majority of the population. With implementation of the NRCMS, the THs, which are the first referral level in rural areas, are more financially accessible for the population whatever the level of income per capita of the township. However, the *increase* in rural net income per capita has a positive influence on the volume of inpatient care delivered, indicating that income continues to be a major determinant of access to hospitalization services. The rise in living standard in the township leads to a decrease in the financial barriers to expensive hospitalization services. Our results suggest that despite the NRCMS being primarily designed to lower hospitalization costs, and despite the impressive development of the scheme over the 2003-2008 period, inpatient care still carries a financial burden. If the availability of insurance had totally removed the financial barriers to access to inpatient care at TH level, the coefficient between income and inpatients would be insignificant, as was the case for outpatients.

4.2. TH Characteristics [17]

Over and above the major role of environmental factors, the characteristics of the THs play differentiated roles on medical consultations and inpatient care.

Considering the estimations on outpatient visits (Table 6), on average, central THs treated two times more outpatients over the period than general THs. This difference in the volume of outpatients, which was highlighted in the descriptive statistics (cf. Section 2), is strongly confirmed by the significant econometric estimations. However, the size of the TH, as measured by number of curative staff, does not influence the volume of medical consultations, indicating that it is not a factor of attractiveness. In contrast, the estimations underlined a negative effect of the amount of subsidies received by the TH. This is a rather puzzling result for which it is difficult to find a clear explanation.

Results are quite different when we consider the estimation on discharged inpatients (Table 7). The type of TH — either central or general — has no effect on volume of discharged inpatients. The number of operational beds has a significant and positive influence on the volume of discharged inpatients: a higher number of available beds equates to a higher volume of discharged inpatients. The number of beds reflects the capacity of the THs to admit inpatients. The residual of medical consultations [18] is significantly and positively linked to the volume of inpatients

17. We verified that significance, sign and magnitude of the coefficients on hospital level variable and on size variables (curative medical staff and number operational beds) are not altered when indicators are entered simultaneously or at the same time into the regression.

18. The residual from the outpatient regressions is included in the estimations of the determinants of the number of inpatients to mimic estimation with instrumental variables. Please see the footnote 15 for more explanations.

discharged, indicating a complementary relationship between medical consultations and hospitalization services.

4.3. Preventive Activity

The hypothesis that preventive activity may positively drive demand for curative activity is confirmed, but surprisingly only for the hospitalization activity (Table 7). The volume of discharged inpatients is significantly and positively influenced by the volume of preventive activities per preventive staff. This relationship is not observed with outpatient visits, whereas we had expected to see a probable effect, whether positive or negative: the coefficient of the volume of vaccinations delivered is non-significant (Table 6). The talks we had with the health bureau led us to think that discussions with the patients or their entourage surrounding preventive–care activities incites patients to go to consult for pathologies that will subsequently require inpatient care. In addition, we have been told that the NRCMS authorities used to organize free examinations during vaccination visits — some of which lead to inpatient care. Our results suggest that curative and preventive activities are complementary in the short term in our sample. Looking in from a different perspective, based on nation-wide data in Taiwan, Tian *et al* (2010) show they are substitutable .

5. Conclusion

The study analyzes the environmental and supply-side factors affecting the volume of curative activities delivered by a sample of THs in Weifang prefecture. THs play a pivotal functional role in the Chinese rural healthcare system by providing curative and preventive care to the rural population. However, their use has declined since the 1980s in the wake of successive waves of socio-economic reform (Liu *et al.*, 1996; World Bank, 1997), prompting government efforts to reverse the trend since the early 2000s (Wagstaff *et al.*, 2009b).

Our results highlight several insights that are useful from a policy perspective. They suggest complementarities — on one hand, between the different kinds of medical activities delivered at TH level, which points to the importance of keeping a comprehensive set of services if THs want to attract more patients, and on the other hand, between village health stations (VHSs) and THs.

The increase in TH activity was largely supported by the development of the NRCMS scheme. Nevertheless, the scheme is quite new, and the increase in activity could be influenced by potential adverse selection problems, as highlighted by earlier studies on the NRCMS (Wang *et al.*, 2006; Wagstaff and Lindelow, 2008; Wang

Table 6 : *Estimation of the determinants of outpatient visits to THs*

	Hausman-Taylor			Fixed-Effect Vector Decomposition			
	(1)	(2)	(3)	(1)	(2)	(3)	(4)
Density	-0.00321*	-0.00327*	-0.00304*	-0.00429**	-0.00434**	-0.00415**	-0.00399**
	(0.00168)	(0.00168)	(0.00167)	(0.00175)	(0.00174)	(0.00174)	(0.00174)
Ln(Rural net inc. p.c)	-0.285	-0.309	-0.261	-0.423	-0.448	-0.398	-0.369
	(0.282)	(0.282)	(0.280)	(0.289)	(0.290)	(0.287)	(0.288)
Participation	0.149*			0.150*			0.0892
	(0.0837)			(0.0840)			(0.0881)
Participation							
Poor							0.163**
							(0.0780)
NRCMS		0.00204**			0.00208**		
		(0.00103)			(0.00104)		
Reimbursement rate			0.00903**			0.00889**	
			(0.00372)			(0.00373)	
# HH per VHS	0.000761***	0.000767***	0.000729***	0.000941***	0.000946***	0.000909***	0.000931***
	(0.000244)	(0.000243)	(0.000242)	(0.000259)	(0.000258)	(0.000257)	(0.000256)
Distance to CH	-0.00441	-0.00464	-0.00384	-0.00741	-0.00763	-0.00687	-0.00752
	(0.0130)	(0.0131)	(0.0130)	(0.0128)	(0.0128)	(0.0127)	(0.0126)
Hospital level	0.722**	0.724**	0.727**	0.735**	0.737**	0.740**	0.707**
	(0.319)	(0.321)	(0.318)	(0.312)	(0.313)	(0.310)	(0.309)
Curative health staff	0.00323	0.00313	0.00296	0.00371	0.00361	0.00349	0.00475
	(0.00285)	(0.00284)	(0.00283)	(0.00286)	(0.00286)	(0.00284)	(0.00288)
Subsidies	-0.00339*	-0.00327*	-0.00303*	-0.00357*	-0.00345*	-0.00322*	-0.00340*
	(0.00181)	(0.00181)	(0.00181)	(0.00182)	(0.00181)	(0.00181)	(0.00180)
Vaccination per preventive staff	-6.75e-07	6.60e-07	3.58e-06	-8.23e-07	5.49e-07	3.11e-06	1.90e-06
	(2.39e-05)	(2.38e-05)	(2.38e-05)	(2.40e-05)	(2.39e-05)	(2.39e-05)	(2.38e-05)
Constant	9.411***	9.392***	9.413***	9.358***	9.339***	9.367***	9.364***
	(0.544)	(0.545)	(0.540)	(0.537)	(0.538)	(0.533)	(0.532)
Observations R-squared	216	216	216	216	216	216	216

Source : Author's calculation with STATA.

Note: year dummy variables are included in the specification but are not listed. *** indicates significance at 1%; ** at 5%; and * at 10%. For each econometric approach adopted (Hausman-Taylor and Fixed-effect Vector Decomposition), three specifications are listed as a function of the insurance indicator retained: participation dummy (column 1), NRCMS rate of coverage (column 2), and outpatient reimbursement rate (column 3). The last column contains an interactive term: "participation*poor".

Table 7 : *Estimation of the determinants of inpatient care at THs*

	Hausman-Taylor			Fixed-Effect Vector Decomposition			
	(1)	(2)	(3)	(1)	(2)	(3)	(4)
Density	-0.00499*	-0.00469*	-0.00476*	-0.00597*	-0.00608*	-0.00599*	-0.00569*
	(0.00275)	(0.00275)	(0.00278)	(0.00312)	(0.00311)	(0.00315)	(0.00314)
Ln(Rural net inc. p.c)	1.623***	1.602***	1.618***	1.605***	1.544***	1.567***	1.658***
	(0.476)	(0.476)	(0.481)	(0.515)	(0.515)	(0.523)	(0.519)
Participation	0.440***			0.440***			0.381**
	(0.147)			(0.149)			(0.158)
Participation							
Poor							0.160
							(0.139)
NRCMS		0.00581***			0.00596***		
		(0.00181)			(0.00183)		
Reimbursement rate			0.00944**			0.00920**	
			(0.00372)			(0.00377)	
# HH by VHS	0.000413	0.000412	0.000407	0.000751*	0.000765*	0.000750*	0.000727
	(0.000370)	(0.000371)	(0.000371)	(0.000447)	(0.000446)	(0.000451)	(0.000448)
Distance to CH	-0.000334	-0.000266	0.000174	-0.00431	-0.00481	-0.00419	-0.00429
	(0.0124)	(0.0126)	(0.0122)	(0.0131)	(0.0133)	(0.0130)	(0.0130)
Hospital level	0.185	0.174	0.189	0.175	0.177	0.189	0.172
	(0.293)	(0.298)	(0.289)	(0.300)	(0.305)	(0.297)	(0.299)
# of operational beds	0.00764*	0.00708*	0.00789*	0.00792*	0.00742*	0.00816*	0.00850**
	(0.00406)	(0.00405)	(0.00410)	(0.00413)	(0.00411)	(0.00417)	(0.00417)
Subsidies	-0.00272	-0.00235	-0.00300	-0.00272	-0.00228	-0.00297	-0.00240
	(0.00307)	(0.00307)	(0.00310)	(0.00309)	(0.00309)	(0.00312)	(0.00311)
Vaccination per preventive staff	0.000123***	0.000125***	0.000114***	0.000132***	0.000136***	0.000123***	0.000136***
	(4.15e-05)	(4.13e-05)	(4.20e-05)	(4.22e-05)	(4.21e-05)	(4.27e-05)	(4.24e-05)
Residual of OP	0.639***	0.632***	0.657***	0.634***	0.626***	0.652***	0.623***
	(0.133)	(0.133)	(0.136)	(0.133)	(0.133)	(0.136)	(0.135)
Constant	8.309***	8.261***	8.271***	8.319***	8.275***	8.280***	8.328***
	(0.747)	(0.749)	(0.753)	(0.757)	(0.759)	(0.764)	(0.757)
Observations R-squared	216	216	216	216	216	216	216

Source : Author's calculation with STATA.

Note: year dummy variables are included in the specification but are not listed. *** indicates significance at 1%; ** at 5%; and * at 10%. For each econometric approach adopted (Hausman-Taylor and Fixed-effect Vector Decomposition), three specifications are listed as a function of the insurance indicator retained: participation dummy (column 1), NRCMS rate of coverage (column 2), inpatient reimbursement rate (column 3). The last column contains an interactive term: "participation*poor".

et al., 2008; Wagstaff *et al.* 2009b; You and Kobayashi, 2009). Hospitalization care in THs is also influenced by the township's economic development level (income per capita), indicating that the insurance scheme does not lift all the financial barriers to access to inpatient care. As the scheme now covers the vast majority of the rural population, incentive initiatives need to focus on the characteristics of the benefit package, on the reimbursement terms, and on the payment provider system.

Our results confirm that there is competition between health facilities in Weifang prefecture [19]. As the road network is good, it is essential to ensure a "pro-equity" and especially a "pro-efficiency" distribution of health facilities within the prefecture and across the counties in order to avoid both bypassing and overlapping the first two primary levels of the healthcare system, i.e. VHSs and THs. Moreover, as the Chinese government wants to strengthen medical services delivery by reinforcing the capacity of VHSs and THs, the low activity levels and low productivity of numerous THs in our sample raises the dual issue of improving healthcare coordination at county level and addressing the geographical distribution of health facilities in order to rationalize healthcare supply capacities within and amongst counties. All these elements converge to push in favor of a clear definition of the mission of health facilities at every level, and strengthening relationships between them in order to build up a coherent, consistent referral system. These issues are crucial for THs, which are positioned above VHSs and below county hospitals.

Moving forward, our results also suggest that enlarging THs in order to provide care to more patients would be a misguided policy, since the bed occupancy rate and the productivity of medical staff remains low for outpatients and inpatients over the period (cf. Section 2). THs should be re-scaled, as they appear to be too large for their volume of activity, despite the recent increase due partly to huge progress in insurance coverage and to an upward trend in income per capita

Regarding the limitations of our study, it can be argued that our results rely on a relatively small THs sample. We could answer that they are representative of THs in Weifang Prefecture, as they represent about 14% of all the THs in this administrative district. Moreover, the randomized hospitals selection process and the 9-year-long survey period compensate for the relatively small number of THs surveyed.

From a methodological standpoint, one of the contributions of this paper is that it uses a new approach that is still only emerging in the literature, i.e. the FEVD technique. Our analysis cross-compares results between the classical

19. This competition was underlined as an inescapable reality in many rural counties across China by Professor Jin Feng (Fudan University) during a workshop in Paris (July) 2012 co-hosted by the FERDI/CERDI, Paris Sorbonne, and Fudan University.

Hausman-Taylor approach and the FEVD estimator. Both methods lead to similar conclusions.

6. Acknowledgements

This paper is part of a research program led in collaboration with the Weifang Health Bureau and the Weifang Medical University in Shandong Province, People's Republic of China.

The authors thank Ningshan Chen, Division Chief, Division of Policy Research, Department of Health Policy and Legislation, Ministry of Public Health, Beijing, for her stimulating comments. They also thank the reviewers for their helpful remarks and suggestions. They express their particular gratitude to the French Embassy in Beijing, especially to Elvire Aronica, Bureau of Social Affairs, and to the University of Auvergne for their financial support to this study.

We would also like to thank the staff of the Weifang Health Bureau, the township hospitals included in our sample, our colleagues, and the master's and PhD students of Weifang Medical University for their excellent collaborative input throughout the project and the very fruitful discussions and stimulating exchanges that we enjoyed throughout this research. We are also grateful to S. Marchand, B. Boidin and the participants of the JESF 2011 for their helpful comments.

References

Andersen, R., and J. F. Newman. 2005. "Societal and Individual Determinants of Medical Care Utilization in the United States." *The Milbank Quarterly,* 83(4): 1-28.

Audibert, M., J. Mathonnat, and N. Chen. 2002. "Infant Mortality and External Openness in Chinese Provinces" In *China and its regions, Economic Growth and Reform in Chinese Provinces*, ed. Mary-Françoise Renard, 167-193. Cheltenham: Edward Elgar.

Baltagi, B. H. 2005. *Econometric Analysis of Panel Data*, New-York: Wiley.

Barbiaz, K. S., G. Miller, H. Yi, L. Zhang, and S. Rozelle. 2011. "New Evidence on the Impact of China's New Rural Cooperative Medical Scheme and its Implications for Rural Primary Healthcare: Multivariate Difference-in-difference Analysis", *BMJ*, 341.

Brown, P. H., and C. Theoharides. 2009. "Health-seeking Behavior and Hospital Choice in China's New Cooperative Medical System" *Health Economics*, 18(2): 47-64.

Chen, C-S., T-C. Liu, H-C. Lin, and W-H. Tian. 2007. "The Effect of Taiwan's National Health Insurance on Infants' Preventive Care Use and of Inpatient Care Use." *Health Policy,* 80(3): 432-43.

Dong, K. 2009. "Medical Insurance System Evolution in China." *China Economic Review*, 20(4): 591-597.

Dong, H., L. Bogg, K. Wang, C. Rehnberg, and V. Diwan. 1999. "A Description of Outpatient Drug

Use in Rural China: Evidence of Differences Due to Insurance Coverage." *International Journal of Health Planning and Management,* 14(1): 41-56.

Eggleston, K., L. Ling, M. Qingyue, M. Lindelow, and A. Wagstaff. 2008. "Health Service Delivery in China: A Literature Review." *Health Economics*, 17(2): 149-165.

Feng, J., and Z. Song. 2009. "Health Care System in Rural China: A Quantitative Approach Based on Heterogeneous Individuals." *Frontiers of Economics in China*, 4(2): 153-172.

Greene, W. 2011. "Fixed Effects Vector Decomposition: A Magical Solution to the Problem of Time Invariant Variables in Fixed Effects Models?" *Political Analysis*, 19(2): 135-146.

Hausman, J. A. 1978. "Specifications Tests in Econometrics." *Econometrica*, 46(6), 1251-1271.

Hausman, J. A., and W. E. Taylor. 1981. "Panel Data and Unobservable Individual Effects." *Econometrica*, 49(6): 1377-1398.

Henderson, G. E., J. S. Akin, P. M. Hutchinson, S.G. Jin, J.M. Wang, J. Dietrich and L.M. Mao. 1998. "Trends in Health Services Utilization in Eight Provinces in China, 1989-1993". *Social Science and Medicine*, 47(12): 1957-1971.

Hillier, S., and J. Shen. 1996. "Health Care Systems in Transition: People's Republic of China. Part I: An Overview of China's Health Care System." *Journal of Public Medicines*, 18(3): 258-265.

Hsiao, W. C. 1984. "Transformation of Health Care in China." *The New England Journal of Medicine*, 310(14): 932-936.

Hsiao, W. C. 1995. "The Chinese Health Care system: Lessons for Other Nations." *Social Sciences & Medicine*, 41(8): 1047-1055.

Hu, T-W., M. Ong, Z-H. Lin, and E. Li. 1999. "The Effects of Economic Reform on Health Insurance and the Financial Burden for Urban Workers in China." *Health Economic,* 8(4): 309-322.

Liu, X., L. Xu, and S. Wang. 1996. "Reforming China's 50000 Township Hospitals Effectiveness, Challenges and Opportunities." *Health Policy*, 38(1): 13-29.

Liu, G. G., Z. Zhao, R. Cai, T. Yamada and T. Yamada. 2002. "Equity in Health Care Access to: Assessing the Urban Health Insurance Reform in China." *Social Science and Medicine,* 55(10): 1779-1794.

Liu, Y., K. Rao, and S. Hu. 2003a. *People's Republic of China. Toward Establishing A Rural Health Protection System.* Beijing: Asian Development Bank.

Liu, Y., K. Rao, and W. C. Hsiao. 2003b. "Medical Expenditure and Rural Impoverishment in China." *Journal of Health, Population and Nutrition*, 21(3): 216-222.

Lopez-Cevallos, D. F., and C. Chi. 2010. "Health Care Utilization in Ecuador: A Multilevel Analysis of Socioeconomic Determinants and Inequality Issues." *Health Policy and Planning*, 25(3): 209-218.

Mundlack, Yair. 1978. "On the Pooling of Time Series and Cross Section Data." *Econometrica*, 46(1): 69-85.

Plumper, T. and V. E. Troeger. 2007. "Efficient Estimation of Time-Invariant and RarelyChanging Variables in Finite Sample Panel Analyses with Unit Fixed Effects." *Political Analysis*, 15(2): 124-139.

Qian, D., R. W. Pong, A. Yin, K.V. Nagarajan, and Q. Meng. 2009. "Determinants of Health Care Demand in Poor, Rural China: The Case of Gansu Province." *Health Policy and Planning*, 24 (5): 324-334.

Sahn, D. E., S. D. Younge, and G. Genicot. 2003. "The Demand for Healthcare Services in Rural Tanzania." *Oxford Bulletin of Economics and Statistics,* 65(2): 241-259.

Sun, X., S. Jackson, G. Carmichael, and A. C. Sleight. 2009. "Catastrophic Medical Payment and Financial Protection in Rural China: Evidence from the New Cooperative Medical Scheme in Shandong Province." *Health Economics*, 18(1): 103-199.

Tian, W-H., C-S. Chen, and T-C. Liu. 2010. "The Demand for Preventive Care Services and its Relationship with Inpatient Services." *Health Policy*, 94(2): 164-174.

Yi, H., L. Zhang, K. Singer, S. Rozelle, and S. Atlas. 2009. "Health Insurance and Catastrophic Illness: A Report on the New Rural Cooperative Medical System in Rural China." *Health Economics*, 18(2): 119-127.

Yip, W., and W. C. Hsiao. 2008. "The Chinese

Health System at a Crossroads." *Health Affairs*, 27(2): 460-468.

Yip, W., W. C. Hsiao, Q. Meng, W. Chen, and X. Sun. 2010. "Realignment of Incentives for Health-care Providers in China." *The Lancet*, 375(9720): 1120-30.

You, X., and Y. Kobayashi. 2009. "The New Cooperative Medical Scheme in China." *Health Policy*, 91(1): 1-9.

Wagstaff, A., and M. Lindelow. 2008. "Can Insurance Increase Financial Risk? The Curious Case of Health Insurance in China." *Journal of Health Economics*, 27(4): 990–1005.

Wagstaff, A., M. Lindelow, G. Jun, X. Ling, and Q. Juncheng. 2009a. "Extending Health Insurance to the Rural Population: An Impact Evaluation of China's New Cooperative Medical Scheme." *Journal of Health Economics*, 28(1): 1-19.

Wagstaff, A., M. Lindelow, S. Wang, and S. Zhang. 2009b. *Reforming China's Rural Health System*. Washington D.C.: World Bank.

Wang, H., D. Gu, and M. E. Dupre. 2008. "Factors Associated with Enrollment, Satisfaction, and Sustainability of the New Cooperative Medical Scheme Program in Six Study Areas in Rural Beijing." *Health Policy*, 85(1), 32-44.

Wang, H., L. Zhang, W. Yip, and W. C. Hsiao. 2006. "Adverse Selection in a Voluntary Rural Mutual Health Care health insurance scheme in China." *Social Science and Medicine*, 63(54): 1236-1245.

Wooldridge, J. M. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge: MIT Press.

World Bank. 1997. *Financing Health Care: Issues and Options for China*. China 2020 series. Washington D.C.: World Bank.

Zhang, X., L-W. Chen, K. Mueller, Q. Yu, J. Liu, and G. Lin. 2011. "Tracking the Effectiveness of Health Care reform in China: A Case Study of Community Health Centers in a District of Beijing." *Health Policy*, 100(2-3): 181-188.